

CLAIMS

What is claimed is:

- 5 1. A rack mount data storage system, comprising:
- a rack mount cabinet having a set of vertical rails defining a central space;
- a power supply subsystem mounted to the set of vertical rails of the rack
- mount cabinet and being disposed within the central space, the power supply
- subsystem having a set of power supplies configured to provide a set of power
- 10 supply signals and a power supply cooling assembly configured to provide air
- flow substantially horizontally from a front of the rack mount cabinet to a back of
- the rack mount cabinet to remove heat from the set of power supplies;
- a disk drive subsystem mounted to the set of vertical rails of the rack
- mount cabinet and being disposed within the central space, the disk drive
- 15 subsystem having a set of disk drives configured to provide high capacity
- non-volatile data storage in response to the set of power supply signals and a disk
- drive cooling assembly configured to provide air flow substantially horizontally
- from the front of the rack mount cabinet to the back of the rack mount cabinet to
- remove heat from the set of the disk drives; and
- 20 a data storage circuitry subsystem configured to operate the disk drive
- subsystem in response to the set of power supply signals, the data storage circuitry
- subsystem including:
- a housing configured to mount to the set of vertical rails of
- the rack mount cabinet within the central space and above both the
- 25 power supply subsystem and the disk drive subsystem;
- a set of circuit boards configured to install in a vertically
- aligned manner within the housing to define a set of vertically
- oriented channels within the central space defined by the set of

vertical rails of the rack mount cabinet; and
5 a fan assembly configured to mount to the set of vertical rails in a position above the housing to generate a vertical air stream through the set of vertically oriented channels and to exhaust the vertical air stream to an external location above the rack mount cabinet.

2. The rack mount data storage system of claim 1, further comprising:

10 an intake duct configured to attach to the set of vertical rails in a position (i) above both the power supply subsystem and the disk drive subsystem and (ii) beneath the housing to deflect incoming air into the set of vertically oriented channels within the central space.

3. The rack mount data storage system of claim 2 wherein the housing includes a
15 card cage configured to hold the circuit boards in a substantially parallel manner, and wherein the data storage subsystem further comprises:

20 a backplane disposed within the card cage in a substantially perpendicular manner to the set of circuit boards to provide a set of high density connections to the set of circuit boards.

4. The rack mount data storage system of claim 3 wherein the set of circuit boards includes a set of front-installation circuit boards which is configured to insert into the card cage through a front of the rack mount cabinet, and a set of rear-installation circuit boards which is configured to insert into the card cage through a rear of the rack mount cabinet; and wherein the backplane includes:

25 a rigid planar member having a front side that faces toward the front of the rack mount cabinet and a rear side that faces toward the rear of the rack mount cabinet,

a set of front backplane connectors disposed on the front side of the rigid planar member to connect with the set of front-installation circuit boards, and

a set of rear backplane connectors disposed on the rear side of the rigid planar member to connect with the set of rear-installation circuit boards.

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5. The rack mount data storage system of claim 4 wherein the set of front-installation circuit boards is configured to perform data storage system operations on the set of disk drives on behalf of a set of external hosts, wherein the set of rear-installation circuit boards is configured to operate as an interface between the set of front-installation circuit boards and the set of external hosts, and wherein the data storage subsystem further comprises:

10 a front door configured to reside adjacent the housing at the front of the rack mount cabinet to operatively control user access to the set of front-installation circuit boards when the set of front-installation circuit boards is inserted into the card cage, and

15 a rear door configured to reside adjacent the housing at the rear of the rack mount cabinet to operatively control user access to the set of rear-installation circuit boards when the set of rear-installation circuit boards is inserted into the card cage, the front and rear doors being configured to (i) prevent air of the vertical air stream from substantially escaping through the front and rear of the rack mount cabinet and (ii) deflect air of the vertical air stream from the intake duct to the fan through the set of vertically oriented channels defined by the set of circuit boards.

25 6. The rack mount data storage system of claim 5 wherein the rigid planar member of the backplane is configured to divide the set of vertically oriented channels into a set of front airways proximate to the front of the rack mount cabinet to carry a first portion of the vertical air stream and a set of rear airways proximate to the

rear of the rack mount cabinet to carry a second portion of the vertical air stream.

7. The rack mount data storage system of claim 5 wherein the fan assembly is configured to provide, as the first portion of the vertical air stream, a first airflow through the set of front airways and a second airflow, as the second portion of the vertical air stream, through the set of rear airways; and wherein the first airflow has a higher velocity than the second airflow.
8. The rack mount data storage system of claim 2 wherein the rack mount cabinet is configured to reside between a rear hot isle at the rear of the rack mount cabinet and a front cold isle at the front of the rack mount cabinet, and wherein the intake duct defines sides that prevent air intake from the rear hot isle and an opening that permits air intake from the front cold isle.
9. The rack mount data storage system of claim 2 wherein the intake duct is configured to substantially intake air for the vertical air stream from both the front of the rack mount cabinet and the back of the rack mount cabinet.
10. The rack mount data storage system of claim 1 wherein the fan assembly includes:
 - a carrier configured to mount to a set of top portions of the set of vertical rails of the rack mount cabinet; and
 - a set of fan subassemblies supported by the carrier, the set of fan subassemblies being configured to exhaust the vertical air stream in a direction that is substantially parallel to the set of vertical rails and into the external location above the rack mount cabinet.
11. The rack mount data storage system of claim 10 wherein the set of fan subassemblies include:

multiple fans disposed in a row, each fan subassembly being configured to insert into the carrier in a horizontal direction that is substantially perpendicular to the vertical air stream.

- 5 12. The rack mount data storage system of claim 11 wherein the multiple fans define a horizontal $M \times N$ array of fans where M is greater or equal to 2 and N is greater or equal to 2, where M is the number of fans in each fan subassembly, and wherein N is the number of fan subassemblies in the set of fan subassemblies.
- 10 13. The rack mount data storage system of claim 11 wherein each fan subassembly is configured to operate independently of the other fan subassemblies to enable hot swapping of an individual fan while other fans remain in operation in response to the set of power supply signals.
- 15 14. The rack mount data storage system of claim 13 wherein each fan subassembly further includes:
 - a status indicator to selectively indicate proper operation and improper operation of the multiple fans of that fan subassembly.
- 20 15. A data storage subsystem for mounting within a rack mount cabinet, the data storage subsystem comprising:
 - a housing configured to mount to a set of vertical rails of the rack mount cabinet;
 - a set of circuit boards configured to install in a vertically aligned manner within the housing to define a set of vertically oriented channels within a central space defined by the set of vertical rails of the rack mount cabinet; and
 - a fan assembly configured to mount to the set of vertical rails in a position above the housing to generate a vertical air stream through the set of vertically
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oriented channels and to exhaust the vertical air stream to an external location above the rack mount cabinet.

16. The data storage subsystem of claim 15 wherein the housing includes a card cage
5 configured to hold the circuit boards in a substantially parallel manner, and wherein the data storage subsystem further comprises:

a backplane disposed within the card cage in a substantially perpendicular manner to the set of circuit boards to provide a set of high density connections to the set of circuit boards.

- 10 17. The data storage subsystem of claim 16 wherein the set of circuit boards includes a set of front-installation circuit boards which is configured to insert into the card cage through a front of the rack mount cabinet, and a set of rear-installation circuit boards which is configured to insert into the card cage through a rear of the rack mount cabinet; and wherein the backplane includes:
15 a rigid planar member having a front side that faces toward the front of the rack mount cabinet and a rear side that faces toward the rear of the rack mount cabinet,
a set of front backplane connectors disposed on the front side of the rigid planar member to connect with the set of front-installation circuit boards, and
20 a set of rear backplane connectors disposed on the rear side of the rigid planar member to connect with the set of rear-installation circuit boards.

- 25 18. The data storage subsystem of claim 17 wherein the set of front-installation circuit boards is configured to perform data storage system operations on a set of disk drives on behalf of a set of external hosts, wherein the set of rear-installation circuit boards is configured to operate as an interface between the set of front-installation circuit boards and the set of external hosts, and wherein the data

storage subsystem further comprises:

a front door configured to reside adjacent the housing at the front of the rack mount cabinet to operatively control user access to the set of front-installation circuit boards when the set of front-installation circuit boards is inserted into the card cage, and

a rear door configured to reside adjacent the housing at the rear of the rack mount cabinet to operatively control user access to the set of rear-installation circuit boards when the set of rear-installation circuit boards is inserted into the card cage, the front and rear doors being configured to (i) prevent air of the vertical air stream from substantially escaping through the front and rear of the rack mount cabinet and (ii) deflect air of the vertical air stream through the set of vertically oriented channels defined by the set of circuit boards.

19. The data storage subsystem of claim 18 wherein the rigid planar member of the

15 backplane is configured to divide the set of vertically oriented channels into a set of front airways proximate to the front of the rack mount cabinet to carry a first portion of the vertical air stream and a set of rear airways proximate to the rear of the rack mount cabinet to carry a second portion of the vertical air stream.

20. The data storage subsystem of claim 19 wherein the fan assembly is configured to provide, as the first portion of the vertical air stream, a first airflow through the set of front airways and a second airflow, as the second portion of the vertical air stream, through the set of rear airways; and wherein the first airflow has a higher velocity than the second airflow.

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21. The data storage subsystem of claim 15 wherein the fan assembly includes:

a carrier configured to mount to a set of top portions of the set of vertical rails of the rack mount cabinet; and

a set of fan subassemblies supported by the carrier, the set of fan subassemblies being configured to exhaust the vertical air stream in a direction that is substantially parallel to the set of vertical rails and into the external location above the rack mount cabinet.

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22. The data storage subsystem of claim 21 wherein each fan subassembly includes:
 - multiple fans disposed in a row, that fan subassembly being configured to insert into the carrier in a horizontal direction that is substantially perpendicular to the vertical air stream.
- 10 23. The data storage subsystem of claim 22 wherein the multiple fans define a horizontal MxN array of fans where M is greater or equal to 2 and N is greater or equal to 2.
- 15 24. The data storage subsystem of claim 22 wherein each fan subassembly is configured to operate independently of the other fan subassemblies to enable hot swapping of an individual fan subassembly while other fan subassemblies remain in operation.
- 20 25. The data storage subsystem of claim 24 wherein each fan subassembly further includes:
 - a status indicator to selectively indicate proper operation and improper operation of the multiple fans of that fan subassembly.
- 25 26. A method for making a rack mount data storage system, the method comprising:
 - mounting a power supply subsystem and a disk drive subsystem to a rack mount cabinet, both the power supply subsystem and the disk drive subsystem being configured to provide substantially horizontal air flow cooling therethrough;

installing data storage circuitry to the rack mount cabinet, the data storage circuitry residing above both the power supply subsystem and the disk drive subsystem; and

5 attaching a fan assembly to the rack mount cabinet, the fan assembly residing above the data storage circuitry, the fan being configured to generate a vertical air stream through the data storage circuitry and exhaust the vertical air stream to an external location above the rack mount cabinet.